

## Forces and Motion

**PS-5 The student will demonstrate an understanding of the nature of forces and motion.**

**PS-5.8 Use the formula  $F = ma$  to solve problems related to force.**

**Taxonomy Level:** 3.2-C Apply Procedural Knowledge

### Key Concepts:

Applied force  
Frictional force  
Net force

**Previous/Future knowledge:** 8<sup>th</sup> grade students analyzed the effects of forces (including gravity and friction) on the speed and direction of an object (8-5.3). They also predicted how varying the force or mass will affect the motion of an object. (8-5.4) This indicator for Physical Science addresses the mathematical dimension of force by solving problems related to force, mass, and acceleration.

### It is essential for students to

- Understand the correct context for the variables in a word problem.
- Understand that a *newton* is defined as the amount of force necessary to accelerate a 1.0 kg object at a rate of 1 meter/second/second.  $\text{force} = (\text{mass})(\text{acceleration})$ 
  - The newton is a *derived* unit, so when you multiply mass times acceleration, if mass is in kilograms and acceleration is in m/s/s, you have the proper units for newtons (kg·m/s/s or kg·m/s<sup>2</sup>).
- Mathematically solve problems for force, mass, or acceleration, using dimensional analysis to identify the units of the answer. (See dimensional analysis PS-1.5)
- Determine the “given” information using the correct units,
  - Mass should be given in kilograms (kg),
  - Acceleration in (m/s/s, or m/s<sup>2</sup>), and
  - Force in newtons. (N)
- Solve problems for any of the variable in the formula,  $F = ma$ . For example, the problem may give net force and mass and the student must find the acceleration ( $a = F/m$ ).

### It is not essential for students to

- Solve problems in Standard English units or convert Standard English units to metric units.
- Solve problems involving scientific notation.
- Solve two-step problems that require first finding acceleration from initial velocity, final velocity and time.
- Solve problems involving friction.

### Assessment Guidelines:

The objective of this indicator is to use the formula,  $F=ma$ , to solve problems related to force, therefore, the primary focus of assessment should be to apply the mathematical formula,  $F = ma$  to novel word problems or new sets of data, not just problems that are familiar.

In addition to *use*, assessment may require that students:

- Apply procedures for manipulating the formula for Newton’s Second Law to solve for any of the variables when given the other two;
- Recognize each of the variables;
- Summarize the interrelationships among the variables.